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#### Provided in Cooperation with:

International Journal of Energy Economics and Policy (IJEPP)

*Reference:* Oyedele, Ovikuomagbe (2023). Determinants of household cooking energy choice : are such choices influenced by health outcomes?. In: International Journal of Energy Economics and Policy 13 (2), S. 553 - 564.

<https://www.econjournals.com/index.php/ijeep/article/download/13977/7254/32841>.

doi:10.32479/ijeep.13977.

This Version is available at:

<http://hdl.handle.net/11159/630207>

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## Determinants of Household Cooking Energy Choice: Are Such Choices Influenced by Health Outcomes?

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Received: 19 November 2022

Accepted: 04 March 2023

DOI: <https://doi.org/10.32479/ijeeep.13977>

### ABSTRACT

Several factors determine a woman's choice of cooking fuel type for her household. Since there are health effects to such decisions, it is consequential that households would take into consideration their health outcome experiences when making such choices. This study examined the determinants of household's cooking energy choice. It examined whether such choices are influenced by health outcomes. A multinomial logit model was estimated, controlling for possible heterogeneity. Higher levels of household wealth index and education promote cleaner energy use such as electricity and gas rather than firewood, charcoal and other solid fuels in both urban and rural locations. Increasing household size reduced the likelihood of household's use of electricity and gas rather than firewood, charcoal and other solid fuels. Richer households were generally more likely to use than poorer households. This was irrespective of whether they had zero child death or at least one child death experience. Thus, policy effort towards achieving energy transition and environmental quality should improve household wealth and women education.

**Keywords:** Energy Choice, Wealth Index, Woman's Education, Solid Fuel, Health Hazards

**JEL Classifications:** D11, D12, D13, D16, I18

### 1. INTRODUCTION

The importance of sustaining the environment by making the right energy use choices, impact on the population health and thus the development of an economy. Several factors determine the choice of fuel used by household for cooking. Traditional fuels such as firewood and coal still remain predominantly used by many households for their basic cooking activities. This calls for concern because of the health implications of being exposed to the unclean gas and pollution that are emitted from traditional fuels. Besides the immediate negative health effect on the household, the cumulative effect from several households amount to poor environmental quality in the community. The large dependence on firewood has had huge deforestation effect, which contributes to climate change. A reduction of air pollution and deforestation are among the many benefits from the clear need to reduce the utilization of bioenergy in all sectors of the economy (International Energy Agency, 2019).

Electricity still remains a luxury to most families in developing countries as a result of its relatively high cost and scarcity. However, solid fuel use is predominantly common. For instance, two billion people worldwide are without access to electricity and an equal number continue to use traditional solid fuels for cooking (World Energy Assessment, 2000). A quarter of humanity are without access to electricity and almost one-half still attend to their thermal needs by depending on solid fuels such as unprocessed biomass, coal and charcoal (Pachauri et al., 2012). The use of less cleaner fuels is common in developing countries as a result of poor economic conditions and low income among many households. This is because they are usually cheaper and less expensive. Firewood and charcoal is a common fuel in Nigeria and all households have access to it since it is relatively cheap so that poor as well as rural households mostly use it. Financially challenged households easily fallback on firewood and charcoal as well as any rich household who desires to use it.

Over 60% of the Nigerian population cook with firewood and use it for a variety of domestic activities (Energy Commission of Nigeria, 2003). Thus part of the objectives of the national energy policy is to reduce the consumption level of firewood, facilitate the use of alternative energy sources and also reduce the health hazards resulting from firewood combustion (Energy Commission of Nigeria, 2003). Based on the NDHS (2018) survey, about 69% of households use some type of solid fuel for cooking with 61% making use of wood. Firewood and charcoal are very ready alternatives that most households stack up especially when they cannot afford other cleaner fuels. Many families basically cook with firewood precisely in rural households and among low-income households.

Traditional and non-commercial fuels are usually relied on by most people in developing countries and inefficient technologies such as unventilated stoves and open fires are used. In some low income developing countries, traditional biomass accounts for 90% or more of total energy consumption (World Energy Assessment, 2000).

Solid fuel use has been shown to have adverse effects on health. Inefficient cooking practices using polluting stoves paired with solid fuels and kerosene has been found to cause household air pollution which cause close to 4 million premature deaths every year (World Health Organization, 2018). Based on World Health Organization (2018), household indoor air pollution caused by the inefficient use of solid fuels and kerosene for cooking is responsible for illnesses such as pneumonia, stroke, lung cancer, chronic obstructive pulmonary disease and ischaemic heart disease. Forty five percent of deaths (among children under 5 years of age) caused by pneumonia has been attributed to inhaling particulate matter from household air (World Health Organization 2021). Ezzati and Kammen (2001) also found that indoor air pollution increased the frequency of acute respiratory infection in Kenya using the logistic regression and a sample of 500 individuals from 80 to 100 households. The indoor air pollution was mainly from domestic biomass fuel use (firewood and charcoal). Biomass is commonly used for cooking in developing countries and more than 90% of energy use in rural areas is attributed to biomass (Barnes and Floor, 1999). They also emphasize that wood and dung is as important as oil and natural gas and as such, biomass still continues to be a critical part of the energy mix in developing countries. The use of unclean cooking fuel is associated with energy poverty even in rural China (Hou et al., 2018).

Stable power supply still remains a challenge in Nigeria and so many households still rely on kerosene, coal and traditional biomass such as animal dung, firewood and dried up leaves. The black smoke emitted from these fuels contribute to adverse climate change and household indoor air pollution. Most Nigerian households use firewood for cooking and kerosene for lighting (Ogwumike et al., 2014). They emphasized the lack of access to modern energy sources that are usually cleaner as a major challenge.

It is therefore pertinent that transition to clean energy sources be encouraged through improvements in issues of availability

and affordability. As shown by WDI (2020) only 56.5% of the population had access to electricity in Nigeria in 2018 from 48% in 2010. Despite the knowledge and experience of the health effects of dirty energy use, many households still rely on the use of unclean energy forms as fuels, for instance, the NDHS (2018) explains that 69% of households use some type of solid fuel for cooking and 61% of such households use wood. Only 15% of Nigerian households use clean fuel for cooking at the national level, with 27% and 4% for the case of urban and rural households respectively (NDHS, 2018).

Several contributions exist in the literature on the determinants of the choice of cooking fuel. Some studies have used nationally representative samples for instance Paudel et al. (2018), Akpalu et al. (2011), Makonese et al. (2017) however, these studies are not specifically for the Nigerian case. Despite several studies that exist for Nigeria, they mostly focused on specific sections of the country. Baiyegunhi and Hassan (2014) analyzed the determinants of household cooking fuel choice, however, it focused only on Giwa local government in Kaduna state. Desalu et al. (2012) focused on South Western Nigeria using households in urban (Ado-Ekiti) and rural (Ido-Ekiti) local council areas. Ogwumike et al. (2014) also examined the determinants of household energy use (including for cooking) in Nigeria however, the study did not examine the influence of health experiences and health consideration on the choice of household cooking fuel. Emphasizing the importance of clean energy use, several studies have shown that the type of energy used could positively or negatively affect health and that solid fuel use negatively affect health as a result of the consequential indoor air pollution (Desalu et al., 2012; Mehta and Shahpar, 2004; Rehfuess et al., 2011; Bassani et al., 2010). Having the knowledge is good but it is more important to use the knowledge for better health outcomes. Based on this, it is important that such knowledge be used in improving population health. Therefore, do women or households consider the consequences of these negative or positive health effect when making decisions on the type of energy or fuel for cooking? There are only few attempts in the literature to address this question. Thus, there remains the need to examine the effect of health considerations on cooking energy choices.

The study first of all examines the determinants of cooking fuel used. It then goes further to examine whether there are differentials based on a woman's health experience which is captured by whether she has experienced child mortality in her household.

Therefore, beyond affordability and access to clean fuel, does health experience and health considerations influence the effect of such determinants on household cooking fuel? This is because the literature also shows that the type of cooking fuel used affect the health status of the users since they are exposed to the resulting health hazards from such fuel (for instance, Bassani et al., 2010; Ezeh et al., 2014; Rinne et al., 2007; Riojas-Rodríguez et al., 2016 amongst others). It is therefore possible that individuals would allow their health conditions and experience to influence their decision on the type of cooking fuel to use.

Therefore in order to establish whether there are differences in behavior with respect to making such decisions with health

considerations, we estimate the determinant for women who have experienced child mortality and for those who have not.

This study examined the determinants of household cooking energy choices in Nigeria using a nationally representative data thus providing a broader scope. It considered urban and rural differentials. It also attempted to answer the question: do health outcomes influence household decision on cooking fuel choice?

## 2. LITERATURE REVIEW

Several studies have examined household behavior with regards to choosing to use clean and modern fuel rather than traditional biomass energy resources. Several factors have been found to significantly explain household cooking fuel choices. However, very little studies have shown the effect of health outcome experiences on cooking fuel decisions of households. Explaining the role of income in Zimbabwe, Hosier and Dowd (1987) showed that economic status explained household switch to cleaner or more sophisticated fuel types as shown by. Estimating a multinomial logit model, Baiyegunhi and Hassan (2014) found that households' use of clean fuel such as kerosene, natural gas and electricity increased with income. Conducting the study for South Western Nigeria using households in urban (Ado-Ekiti) and rural (Ido-Ekiti) local council areas, Desalu et al. (2012) found some associations between some factors and some forms of solid fuel, for instance, high income and having a modern house were associated with the use of gas in urban areas while high wealth level were associated with the use of gas in rural areas. Income was also found by Amoah (2019) to have an increasing effect on the likelihood to use liquefied petroleum gas (LPG) rather than charcoal in Ghana. Thus, the fact that charcoal is cheaper, readily available and easy to use encouraged more of its use. Estimating household energy consumption determinants by income group, Hosier and Kipondya (1993) showed that woodfuel was substituted for modern fuels such as electricity and LPG with increases in income making charcoal an inferior good among higher income groups while electricity and LPG were more of normal economic goods across the income groups.

Baiyegunhi and Hassan (2014) also found that the older the household head, the less likely would be the choice of natural gas relative to using fuelwood. More years of schooling of the household head increased the transition from fuelwood to kerosene and natural gas. Increased household size however, reduced the probability of use of natural gas rather than fuelwood. Based on an Ethiopian study, households actually use multiple fuels rather than completely switching to cleaner fuel when income levels increase (Mekonnen and Kohlin 2009). Thus households do not just move up the energy ladder but use more than one fuel type. This makes the fuel stacking model a point of emphasis in their study of the determinants of household use of solid fuel, non solid fuel or a mix of both. Increase in family size reduced the likelihood of a household choosing non-solid fuels. This is also supported by Paudel et al. (2018). Education however increased households' choice for non-solid fuels and older household heads were more likely to choose solid fuels only as shown by Paudel et al. (2018); while female headed households were more likely

to use only solid fuel or a mix of both solid and non-solid fuels. Rahut et al. (2016) however found that female headed households were more likely to use cleaner energy sources for cooking. The probability of switching to cleaner sources of energy for lighting, cooking and heating increased with the age and education of the household head, higher levels of income, urban residence and having a female headed household (Rahut et al., 2014).

As mentioned above, education has been identified as capable of determining the choice of cooking fuel type. Educated women are more likely to take seriously and appreciate the health concerns associated with the type of fuel used in terms of their potential health hazards. Such awareness could be gotten from public health programmes freely broadcasted on television or organized in the community especially with the growing concerns from private groups, national and international organizations on the environmental and health consequences of energy production and usage. This could therefore influence their decisions. Using a panel multinomial logit approach, Alem et al. (2015) found that education, economic status and the price of alternative energy sources determined household cooking energy choice in urban Ethiopia. Households switched to an alternative fuel when the price of a particular fuel increased. They also observed that households also displayed the fuel stacking behavior. Makonese et al. (2017) examined the cooking fuel types and the determinants of household choice of cooking fuel in selected countries in sub-Saharan Africa. Electricity access, household size, education and wealth index had a positive influence on the type of cooking fuel used in favour of more use of modern and cleaner cooking fuels than traditional fuels. However, access to electricity did not imply that households would negate the use of traditional fuels. Heltberg (2005) also found that having more education was found to increase the probability of the use of only LPG than the joint use of wood and LPG, while it reduced the chances of using only wood in both urban and rural areas. Having an educated household head also increased modern fuel use rather than fuelwood or other biomass in rural Pakistan (Imran and Ozcatalbas, 2020). This was confirmed in Ghana as Amoah (2019) after estimating a probit model also found that having a household head with a basic, secondary and tertiary education increased the use of LPG rather than charcoal. Nwankwo et al. (2018) found that there was a low level of knowledge about the adverse health effects of exposure to biomass smoke among more than half of the food vendors sampled from two states in Nigeria. They also found that even a greater number had poor attitudes towards preventing exposure and were unconcerned. The need for more health education was emphasized.

Examining the link between energy poverty and fuel choice among low income urban households in Kisumu city of Kenya, Olang et al. (2018) discovered that the challenge of access was a key determinant of the energy choice of households with higher levels of energy poverty; others include the type of energy appliance and the cooking location. The multidimensional energy poverty index was used and lighting and cooking activities were considered. Urban and wealthy households were more likely to use cleaner sources of energy. This finding was also obtained by Rahut et al. (2016) for the case of sub-Saharan Africa and Paudel et al. (2018) confirmed this finding to also be applicable to Afghanistan.

Preference for alternatives which usually consist of a mixture of clean and less cleaner fuel types result in fuel stacking. Fuel stacking has also been found to be a common behavior among households. Mekonnen and Kohlin (2009) also confirmed this among Ethiopian households. Fuel stacking involves the use of multiple fuels such that a household has alternatives and backups. These alternatives would usually consist of more readily available and cheaper fuels including charcoal. Charcoal production and use contribute to poverty reduction in sub-Saharan Africa (Zulu and Richardson 2012) hence, in order to reduce the use of such unclean fuels, it is pertinent for policy to provide other alternatives for earning income as well as increase access to cheaper and cleaner energy sources. Using data from the Nigeria Living Standard Survey 2004 and estimating a multinomial logit model, Ogwumike et al. (2014) found that per capita expenditure had a significant inverse relationship with firewood use, a significant positive relationship with kerosene use and LPG use. This was also the case for probability variations. However it was not significant to explain electricity use. Urban residence increased the probability for firewood consumption but reduced the probability for kerosene, LPG and electricity use as the main cooking fuel. Heltberg (2005) found that farm households in Guatemala were more likely to use only wood for cooking than the joint use of wood and LPG. Ouedraogo (2006) explained that firewood was the most commonly used energy source for cooking in Burkina Faso even by urban households. Using an extensive survey on household expenditure in Quagadougou and employing a multinomial logit model, poverty factors including low household income, lack of access to electricity for primary and secondary energy amongst others were found to be significant determinants of cooking energy choices by urban households. In addition, firewood use declined with increasing household income. Thus, until these poverty issues are addressed, firewood would continue to be a mostly used energy source.

The literature has shown that solid fuel and biomass use affect the health of individuals including child health. Bassani et al. (2010) explained that solid fuel use increase child mortality due to acute respiratory infection and estimated the direct effect of solid fuel use on child mortality in India. They found that solid fuel use increased child deaths, which occurred at ages 1-4 years. They concluded that solid fuel use might have been responsible for about 6% and 20% of all deaths from ages 0 to 4 years and 1 to 4 years respectively. Acute respiratory infections and acute lower respiratory infection was found to increase among children and adults in households who are exposed to particulate matter smaller than 10 $\mu$ m due to the use of biomass fuels which mainly included firewood and charcoal. The study used 55 randomly selected households in central Kenya.

Assessing the risk of exposure to wood smoke, Riojas-Rodríguez et al. (2016) found that the use of firewood increased the risks of respiratory symptoms such as difficulty breathing and common cold in Indian children and women in Mexico. However a reduction in such risks, which may contribute to complicated respiratory diseases and mortality was associated with the use of improved cooking stoves, which usually require less wood for cooking. Data was obtained using questionnaires and the amount of particulate matter concentrations was monitored in homes

and found to be lower in households using improved stoves. For the case of biomass fuel, Mishra (2003) found that children in households using biomass fuel including firewood were found to be more than twice likely to have acute respiratory infection than those in households using cleaner fuel including gas or electricity. A study of eighty households in Ecuador by Rinne et al. (2007) also revealed that households that cook with a greater proportion of biomass fuel had a significantly higher infant mortality. Amegah et al. (2012) also found low birth weight to be significantly explained by a mother's use of charcoal for household cooking during pregnancy rather than the use of LPG only. The burning of garbage at home also increased low birth weight and negatively affected average fetal growth. The risk of mortality among children is said to be one of the highest from indoor air pollution due to the use of firewood for cooking (Heltberg, 2005). Emphasizing on the negative health implications of biomass fuel use on women's health due to exposure to smoke hazards, since a higher percentage of households use firewood and women are the most users for cooking activities in Pakistan, Imran and Ozcatalbas (2020) estimated the determinants of household cooking fuels and their health impact on women. The study found that income increase encouraged household transition from biomass to the use of mix fuels as the expensive ness of commercial fuels compared to the relatively free and available biomass as well as lack of access to electricity and LPG significantly promoted biomass fuel use.

For the case of Nigeria, the use of solid fuel by households was found to be associated with post neonatal mortality and child mortality as shown by Ezech et al. (2014). The study also found that the risk of child death due to solid fuel use increased with rural residence and if the household is poor. Heavy dependence and continuous use of firewood and other plant biomass reduce the trees and forest environments which make use of carbon dioxide (CO<sub>2</sub>) emitted, thus reducing the negative impact of its excess levels on human health. Oyedele (2022) have shown that increasing CO<sub>2</sub> emission significantly explained infant and under five mortality in Nigeria, with CO<sub>2</sub> emission from solid fuel having the greatest contribution.

Thus, considering health considerations, it is possible that women could allow their health experiences influence their behavior with respect to making decisions on the type of cooking fuel to use. Thus the determinants of the type of cooking fuel to use could differ amongst women who have experienced some negative health outcomes and those who have not. This remains a gap in the literature and this study attempts to make a contribution in this regard.

### 3. METHODS AND DATA

#### 3.1. Data and Ethical Consideration

This study makes use of data from the Nigeria Demographic and Health Survey for 2018. This is a nationally representative data capturing both urban and rural households published by the National Population Commission Abuja, Nigeria and The DHS Program ICF Rockville, Maryland, USA. The review and approval of the survey protocol was done by the National Health Research Ethics Committee of Nigeria and the ICF Institutional Review Board. Information used were those obtained from female

respondents in the survey, which consist of women within the reproductive ages of 15-49 years. The sample used for the study was 21,792 women. The study made use of women responses as a representative response for their households since women are more likely than men to carry out household kitchen activities in terms of doing the cooking, purchasing household cooking needs including foodstuff and cooking fuel and thus are in a better position to make decision on the cooking fuel type.

### 3.2. Data Availability

The data used is a secondary data and include data on the type of fuel used which is categorized into household uses electricity, household uses LPG/natural gas/biogas, household uses kerosene, household uses coal/firewood/charcoal/other solid fuels, and household decides not to cook. The base category is the household use of coal/firewood/charcoal/other solid fuels. The comparison is between the probabilities of any of these choices being made rather than the base category. Household wealth was captured using the wealth index, which is based on the number and kinds of consumer goods. The households are thus categorized into poor, middle and rich households. A poor household is one that owns the least number and kinds of consumer goods compared with other households. Using dummy variables, data on education is decomposed into no education, primary education, secondary education and post secondary education. The value is equal to 1 if the woman has no education and 0 if otherwise. This also applies for other dummy categories. Whether a woman is employed or unemployed was also captured by a dummy variable with a value

of 1 if employed and 0 if she is not employed. Data on other household and environmental characteristics were also obtained as shown in Table 1. The survey data is published on the DHS website. (<https://dhsprogram.com>).

### 3.3. The Model and Estimation Method

The model for the study is a multinomial logit model where the dependent variable is the choice of cooking fuel type, which are the five mutually exclusive alternative types of cooking fuel. The five categories include electricity; LPG/natural gas/biogas; kerosene; coal/charcoal/firewood/other solid fuels; and no cooking in household. The base category is the use of coal/charcoal/firewood/other solid fuels. The study presents the choice of cooking fuel used by a household as dependent on some explanatory variables such as woman's characteristics including age, education, employment; household characteristics including age, gender, and educational attainment of the household head, household wealth, household size as well as environmental characteristics including urban and rural residence. The data is limited with respect to the prices of fuels. The multinomial logit model is appropriate because the explanatory variables are invariant across the alternatives. The model also allows the coefficient of the regressors to vary across alternatives and it is given as:

$P(y = j | x) = f(x'\beta_j) \quad j = 1, 2, \dots, n$ . Where  $n = 5$  and  $x$  represent the list of explanatory variables.

Let  $x$  be a  $1 \times K$  vector with first element unity. The multinomial logit (MNL) model has response probabilities

$$P(y = j | x) = \frac{\exp(x\beta_j)}{1 + \sum_{h=1}^n \exp(x\beta_h)}, \quad j = 1, \dots, n$$

where  $\beta_j$  is  $K \times 1$ , and  $j = 1, \dots, n$ . The probabilities of the responses must sum up to unity.

We expect household characteristics such as education to positively influence the use of cleaner fuel types such as electricity and gas as a result of the benefits to the environment and health. However, the choice of less cleaner fuels such as firewood or charcoal are usually relatively less expensive and therefore expected to be a more likely choice with lower household wealth and unemployment. The maximum likelihood estimation method was employed. The estimation was conducted at the national level and for urban and rural households. Possible heterogeneity was controlled for using robust standard errors. The results are presented in Table 2 at the national level and in Tables 3 and 4 for urban and rural households respectively.

## 4. RESULTS AND DISCUSSION

The descriptive statistics in Table 1 shows that a greater percentage of households precisely 82% use firewood, charcoal and other solid fuels. This is followed by 8.42% of households that use kerosene. Thus, more than 90% of households used unclean or dirty fuel for cooking. A greater percentage of households precisely 45.6% are poor. A greater percentage of women had no education, precisely 43.7%. Thus, with a greater percentage of household being poor and more women being uneducated, it should not be a surprise that a greater use of solid fuels was observed among households.

**Table 1: Variable definition and descriptive statistics**

Variable	Mean	Standard deviation
Type of cooking fuel		
Household uses electricity	0.0051	0.0715
Household uses LPG/natural gas/biogas	0.0768	0.2662
Household uses kerosene	0.0842	0.2776
Household uses coal/firewood/charcoal/other solid fuels	0.8200	0.3842
Household decides not to cook	0.0139	0.1171
Education		
Woman has no education	0.4372	0.4960
Woman has primary education	0.1565	0.3633
Woman has secondary education	0.3242	0.4681
Woman has post-secondary education	0.0822	0.2747
Household wealth		
Household is poor	0.4557	0.4980
Household is in the middle wealth index	0.2104	0.4076
Household is rich	0.3339	0.4716
Employment		
Woman is not employed	0.3202	0.4665
Woman is employed	0.6798	0.4665
Residence		
Urban residence	0.3538	0.4782
Rural residence	0.6462	0.4782
Others		
Woman's age	29.7314	7.1921
Household size	6.8755	3.756
Male headed household	0.8954	0.3061
Female headed household	0.1046	0.3061
Age of household head	41.7139	12.2602
Total sample	21,792	21,792

\*Mean value multiplied by 100 gives the percentage

**Table 2: Estimates of the cooking energy choice model at the national level**

Variables	Coefficient (t-statistic) [Std. error] Electricity	Coefficient (t-statistic) [Std. error] LPG/ Natural gas/Biogas	Coefficient (t-statistic) [Std. error] Kerosene	Coefficient (t-statistic) [Std. error] No food cooked in house
Household is poor	RC	RC	RC	RC
Household is in the middle	1.684 (2.10)**[0.803]	0.710 (1.84)[0.386]	2.599 (8.88)*[0.293]	0.189 (1.11)[0.171]
Household is rich	4.060 (5.46)*[0.743]	4.328 (13.15)*[0.329]	4.785 (16.80)*[0.285]	0.639 (3.76)*[0.170]
Woman's education				
No education	RC	RC	RC	RC
Primary education	0.587 (1.37)[0.427]	0.974 (4.62)*[0.211]	1.054 (7.63)*[0.138]	0.488 (2.42)**[0.202]
Secondary education	0.596 (1.65)[0.361]	1.798 (10.01)*[0.180]	1.389 (11.29)*[0.123]	0.902 (5.05)*[0.179]
Post-secondary education	1.542 (3.97)*[0.388]	3.158 (16.96)*[0.186]	1.472 (10.42)*[0.141]	1.473 (6.40)*[0.230]
Woman is unemployed	RC	RC	RC	RC
Woman is employed	-0.283(-1.32)[0.215]	0.247 (3.06)*[0.081]	0.236 (3.29)*[0.072]	-0.125(-0.96)[0.130]
Woman's age	0.029 (1.96)[0.015]	0.046 (7.55)*[0.006]	0.034 (6.49)*[0.005]	-0.036(-4.04)*[0.009]
Household characteristics				
Male headed household	RC	RC	RC	RC
Female headed household	0.104 (0.38)[0.272]	-0.092(-0.90)[0.102]	0.179 (2.04)**[0.088]	0.931 (6.01)*[0.155]
Age of household head	-0.026(-2.23)**[0.012]	-0.016(-4.66)*[0.003]	-0.014(-4.32)* [0.003]	0.049 (12.08)*[0.004]
Household size	-0.198(-4.57)*[0.043]	-0.258(-14.14)*[0.018]	-0.248(-16.00)*[0.015]	0.001 (0.08)[0.019]
Urban residence	RC	RC	RC	RC
Rural residence	-0.691(-3.14)*[0.220]	-1.189(-15.11)*[0.079]	-0.658(-10.46)*[0.063]	-0.056(-0.42)[0.133]
Wald Chi <sup>2</sup>	3587.77	3587.77	3587.77	3587.77
Prob >Chi <sup>2</sup>	0.0000	0.0000	0.0000	0.0000

\* and \*\* imply significance at 1% and 5% levels respectively. RC: Reference category. Base outcome: Coal/Charcoal/Firewood/other solid fuel

**Table 3: Estimates of the cooking energy choice model for the urban location**

Variables	Coefficient (t-statistic) [Std. error] Electricity	Coefficient (t-statistic) [Std. error] LPG/ Natural gas/Biogas	Coefficient (t-statistic) [Std. error] Kerosene	Coefficient (t-statistic)[Std. error] No food cooked in house
Probability that household is poor	RC	RC	RC	RC
Probability that household is in the middle	0.758 (0.67)[1.130]	1.699 (1.64)[1.039]	2.155 (4.69)*[0.459]	-0.476(-1.57)[0.304]
Probability that household is rich	3.220 (3.15)*[1.021]	5.488 (5.47)*[1.003]	4.394 (9.83)*[0.447]	0.238 (0.94)[0.253]
Woman's education				
No education	RC	RC	RC	RC
Primary education	0.069 (0.13)[0.512]	1.050 (4.09)*[0.257]	1.041 (6.33)*[0.165]	0.629 (1.62)[0.388]
Secondary education	0.243 (0.63)[0.384]	1.966 (8.81)*[0.223]	1.338 (9.20)*[0.145]	1.026 (3.03)*[0.339]
Post-secondary education	1.315 (3.19)*[0.412]	3.341 (14.45)*[0.231]	1.376 (8.23)*[0.167]	1.890 (5.01)*[0.377]
Woman is unemployed	RC	RC	RC	RC
Woman is employed	-0.431(-1.75)[0.246]	0.199 (2.13)**[0.093]	0.247 (2.82)*[0.088]	-0.292(-1.42)[0.205]
Woman's Age	0.032 (1.81)[0.017]	0.056 (7.67)*[0.007]	0.041 (6.18)*[0.007]	-0.037(-2.52)**[0.015]
Household characteristics				
Male headed household	RC	RC	RC	RC
Female headed household	-0.143(-0.42)[0.340]	-0.237(-1.94)[0.122]	0.127 (1.18)[0.108]	0.977 (4.42)*[0.221]
Age of household head	-0.020(-1.30)[0.016]	-0.019(-4.64)*[0.004]	-0.011(-2.89)*[0.004]	0.052 (8.49)*[0.006]
Household size	-0.287(-5.07)*[0.057]	-0.270(-12.30)*[0.022]	-0.257(-13.91)*[0.018]	-0.057(-1.90)[0.030]
Wald Chi <sup>2</sup>	1964.03	1964.03	1964.03	1964.03
Prob >Chi <sup>2</sup>	0.0000	0.0000	0.0000	0.0000

\* and \*\* imply significance at 1% and 5% levels respectively. RC: Reference category. Base outcome: Coal/Charcoal/Firewood/other solid fuel

#### 4.1. Household Cooking Energy Choice at the National Level

At the national level, as shown in Table 2, being from a household in the middle wealth index increased the likelihood of electricity use by 1.68. This implies that women from households in the middle wealth index are more likely to use electricity rather than firewood, charcoal and other solid fuels than women from poor households. Women from rich households were also more likely to use electricity rather than firewood, charcoal and other solid fuels than women from poor households. This is shown by the positive coefficient of 4.06 and is highly significant at the 1% level. Women with a post-secondary

education were more likely to use electricity rather than firewood, charcoal and other solid fuels than women that have no education. This is similar to Amoah (2019) and Makonese et al. (2017) that found a positive effect of education and wealth index. Education increases the health awareness of the adverse effects of solid fuel use thus it is not surprising that it was highly significant only at higher levels of education. This was highly significant, however, primary and secondary education were insignificant. A woman's employment and age as well as the sex of the household head were not significant. This is contrary to Rahut et al. (2016) that found female household head significant to increase cleaner energy use. The older the household head, the less likely that electricity would

**Table 4: Estimates of the cooking energy choice model for rural location**

Variables	Coefficient (t-statistic) [Std. error] Electricity	Coefficient (t-statistic) [Std. error] LPG/ Natural gas/Biogas	Coefficient (t-statistic) [Std. error] Kerosene	Coefficient (t-statistic) [Std. error] No food cooked in house
Probability that household is poor	RC	RC	RC	RC
Probability that household is in the middle	1.857 (1.88)[0.987]	0.764 (1.67)[0.457]	2.802 (7.35)*[0.381]	0.474 (2.46)**[0.193]
Probability that household is rich	4.132 (4.71)*[0.877]	4.178 (12.30)*[0.340]	4.931 (13.34)*[0.370]	0.842 (3.94)*[0.214]
Woman's education				
No education	RC	RC	RC	RC
Primary education	2.189 (2.29)**[0.958]	0.782 (2.19)**[0.358]	1.095 (4.22)*[0.259]	0.419 (1.73)[0.243]
Secondary education	2.068 (2.23)[0.929]	1.320 (4.57)*[0.289]	1.534 (6.58)*[0.233]	0.883 (3.94)*[0.224]
Post-secondary education	2.651 (2.72)*[0.975]	2.650 (8.72)*[0.304]	1.769 (6.66)*[0.265]	0.869 (2.31)**[0.377]
Woman is unemployed	RC	RC	RC	RC
Woman is employed	0.092 (0.20)[0.463]	0.383 (2.15)**[0.178]	0.189 (1.51)[0.125]	-0.018(-0.11)[0.168]
Woman's age	0.034 (1.19)[0.028]	0.022 (1.98)**[0.011]	0.022 (2.58)*[0.009]	-0.036(-3.18)*[0.011]
Household characteristics				
Male headed household	RC	RC	RC	RC
Female headed household	0.629 (1.38)[0.456]	0.334 (1.82)[0.183]	0.256 (1.69)[0.152]	0.867 (3.98)*[0.218]
Age of household head	-0.042(-2.93)[0.014]	-0.005(-0.89)[0.006]	-0.019(-3.31)*[0.006]	0.047 (8.76)*[0.005]
Household size	-0.028(-0.47)[0.059]	-0.238(-7.29)*[0.033]	-0.236(-7.99)*[0.030]	0.039 (1.64)[0.024]
Wald Chi <sup>2</sup>	1842.53	1842.53	1842.53	1842.53
Prob >Chi <sup>2</sup>	0.0000	0.0000	0.0000	0.0000

\* and \*\* imply significance at 1% and 5% levels respectively. RC: Reference category. Base outcome: Coal/Charcoal/Firewood/other solid fuel

be used for cooking rather than firewood, charcoal and other solid fuels. Households were also less likely to use electricity rather than firewood, charcoal and other solid fuels when there is an increase in household size. The resources available to households decline with increasing household members thus reducing the households' ability to afford electricity. Rural households were significantly less likely to use electricity rather than firewood, charcoal and other solid fuels than urban households. This could be due to the fact that power supply still remains a challenge in the country and the uneven level of development and infrastructural availability leaves rural areas less developed than urban areas.

Women from rich households were more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women from poor households. This was even highly significant at the 1% level. Women from households in the middle wealth index were also more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women from poor households, however it was insignificant. Women were more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels when women were educated, whether at the primary level, secondary level and at the post secondary level than when they had no education. Education therefore promotes the use of cleaner sources of energy. This was highly significant at the 1% level. This is consistent with Baiyegunhi and Hassan (2014). Employed women were significantly more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women who were not employed. This could be due to the fact that since time is usually required for the gathering and collection of solid fuels and this collection is mostly done by women and children, an employed woman has less time available for the gathering of solid fuels since she has to work. Woman's age had a positive significant effect, thus as an increase in a woman's age increased the likelihood that her household would use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels. Older household heads and an increase in the household size reduced the likelihood that a household would use LPG, natural

gas or biogas rather than firewood, charcoal and other solid fuels. Rural households were significantly less likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than urban households.

An increase in the probability that a household was in the middle wealth index and from a rich household increased the likelihood of kerosene use by 2.60 and 4.79 respectively. This implies that women from households in the middle wealth index as well as from a rich household were more likely to use kerosene than firewood, charcoal and other solid fuels than poor households. Firewood, charcoal and other solid fuels are relatively cheaper than kerosene and so we see the role of wealth and resources explaining the affordability implications on household cooking energy choice. Educated women were also more likely to use kerosene than firewood, charcoal and other solid fuels than women with no education. This was significant at the primary, secondary and post secondary levels. This is consistent with Baiyegunhi and Hassan (2014). Employed women as well as older women were also more likely to use kerosene than firewood, charcoal and other solid fuels. Female headed households were also significantly more likely to use kerosene than firewood, charcoal and other solid fuels than male headed households. Older household heads and an increase in the household size significantly reduced the likelihood that a household would use kerosene rather than firewood, charcoal and other solid fuels. Rural households were significantly less likely to use kerosene rather than firewood, charcoal and other solid fuels than urban households. Thus women from rural households as well as women with older household heads were more likely to use firewood, charcoal and other solid fuels than kerosene.

Women from rich households were more likely to rather not cook than use firewood, charcoal and other solid fuels than women from poor households. Women from households in the middle wealth index were also more likely to rather not cook than use firewood, charcoal and other solid fuels than women from poor households, however it was insignificant. Women with a primary education, secondary education



and those with a post secondary education were significantly more likely not to cook than use firewood, charcoal and other solid fuels than women who had no education. A woman's employment status was insignificant. Woman's age had a negative significant effect, thus as an increase in a woman's age reduced the likelihood that her household would decide not to cook than use firewood, charcoal and other solid fuels. Having a female household head and an older household head increased the likelihood that a household would decide not to cook than use firewood, charcoal and other solid fuels. Household size and rural residence were insignificant.

#### 4.2. Household Cooking Energy Choice in Urban Locations

Considering urban locations as shown in Table 3, being from a household in the middle wealth index was not significant. Women from rich households were more likely to use electricity rather than firewood, charcoal and other solid fuels than women from poor households and this was highly significant at the 1% level. This is consistent with Rahut et al. (2016) that found urban and wealth households more likely to use cleaner energy sources. Women with a post secondary education were more likely to use electricity rather than firewood, charcoal and other solid fuels than women that have no education. Primary and secondary education were insignificant. A woman's employment and age as well as the sex of the household head were not significant. Having an older household head was also insignificant. Households were less likely to use electricity rather than firewood, charcoal and other solid fuels when there is an increase in household size. Thus, declining household resources per head reduced the households' ability to afford electricity. In summary, among urban households, only higher levels of wealth and education could encourage the use of electricity rather than firewood, charcoal and other solid fuels. Household size had a reduction effect.

Being from a household in the middle wealth index was insignificant. Women from rich households were significantly more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women from poor households. This also supports the findings of Rahut et al. (2016). Women were more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels when women were educated, whether at the primary level, secondary level and at the post secondary level than when they had no education. Education therefore promotes the use of cleaner sources of energy as obtained at the national level. This was highly significant at the 1% level. Employed women were significantly more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women who were not employed. This is similar to the result obtained at the national level. Woman's age had a positive significant effect, thus as an increase in a woman's age increased the likelihood that her household would use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels. Older household heads and an increase in the household size reduced the likelihood that a household would use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels. The sex of the household head was insignificant.

Households in the middle wealth index as well as rich households

were more likely to use kerosene than firewood, charcoal and other solid fuels than poor households. Firewood, charcoal and other solid fuels are relatively cheaper than kerosene and so we see the role of wealth and resources explaining the affordability implications on household cooking energy choice. Educated women were also more likely to use kerosene than firewood, charcoal and other solid fuels than women with no education. This was significant at the primary, secondary and post secondary levels just as was obtained at the national level. Employed women as well as older women were also more likely to use kerosene than firewood, charcoal and other solid fuels. The sex of the household head was insignificant.

Older household heads and an increase in the household size significantly reduced the likelihood that a household would use kerosene rather than firewood, charcoal and other solid fuels just as was obtained at the national level.

Being from a household in the middle wealth index as well as rich household was insignificant. Women with a secondary education and those with a post secondary education were significantly more likely not to cook than use firewood, charcoal and other solid fuels than women who had no education. Having a primary education was however not significant. A woman's employment status was insignificant. Similar to the result at the national level, woman's age had a negative significant effect, thus as an increase in a woman's age reduced the likelihood that her household would decide not to cook than use firewood, charcoal and other solid fuels. Having a female household head and an older household head increased the likelihood that a household would decide not to cook than use firewood, charcoal and other solid fuels. This is similar to the result obtained at the national level. Household size was however insignificant.

#### 4.3. Household Cooking Energy Choice in Rural Locations

For the case of rural households as shown in Table 4, education and wealth were the only significant variables explaining electricity use. Being from a household in the middle wealth index was not significant. Only women from rich households were more likely to use electricity rather than firewood, charcoal and other solid fuels than women from poor households and this was highly significant at the 1% level. Women with a primary and post secondary education were more likely to use electricity rather than firewood, charcoal and other solid fuels than women that have no education. Secondary education was insignificant.

Just like electricity, only women from rich households were significantly more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women from poor households. Educated women were significantly more likely to use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels than women that had no education. This was significant at the primary, secondary and at the post secondary levels. This is similar to Imran and Ozcatbas, (2020) that found education of household head to increase modern fuel use rather than fuelwood use in rural Pakistan. Employed women were significantly more likely to use LPG, natural gas or biogas rather

than firewood, charcoal and other solid fuels than women who were not employed. This is similar to the result obtained at the national level and for urban households. Woman's age had a positive significant effect, thus as an increase in a woman's age increased the likelihood that her household would use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels. This was also the case at the national level and for urban households. Older household heads and the sex of the household head were insignificant. Among rural households, an increase in household size reduced the likelihood that a household would use LPG, natural gas or biogas rather than firewood, charcoal and other solid fuels just as was obtained at the national level and urban locations.

Households in the middle wealth index as well as rich households were more likely to use kerosene than firewood, charcoal and other solid fuels than poor households. Firewood, charcoal and other solid fuels are relatively cheaper than kerosene and so we see the role of wealth and resources explaining the affordability implications on household cooking energy choice. Educated women were also more likely to use kerosene than firewood, charcoal and other solid fuels than women with no education. This was significant at the primary, secondary and post secondary levels just as was obtained at the national level. Employed women as well as older women were also more likely to use kerosene than firewood, charcoal and other solid fuels. The sex of the household head was insignificant. Older household heads and an increase in the household size significantly reduced the likelihood that a household would use kerosene rather than firewood, charcoal and other solid fuels just as was obtained at the national level.

Rural women from households in the middle wealth index as well as rich household were more likely not to cook than use firewood, charcoal and other solid fuels than women from poor households. This is contrary to the insignificance obtained among urban households. Women with a secondary education and those with a post secondary education were significantly more likely not to cook than use firewood, charcoal and other solid fuels than women who had no education. Having a primary education was however not significant just as was obtained among urban households. A woman's employment status was insignificant just as was obtained in urban locations. Similar to the result at the national level, woman's age had a negative significant effect, thus as an increase in a woman's age reduced the likelihood that her household would decide not to cook than use firewood, charcoal and other solid fuels. Having a female household head and an older household head increased the likelihood that a household would decide not to cook than use firewood, charcoal and other solid fuels. This is similar to the result obtained at the national level and in urban locations. Household size was insignificant in rural locations just as was obtained in urban locations.

#### **4.4. Household Energy Choice Behaviour among Households with Different Health Experiences: The Case of Child Mortality**

The choice of energy for cooking, lighting and other activities has consequences on health outcomes including child mortality, health expenditures among others. This could be through the direct effect on the quality of the household's indoor air. Thus, we expect that

a household's decisions on energy use should be influenced by the health experiences of such household. However, is this the case? One common and persistently occurring experience is the high under five mortality rate. Nigeria is still faced with the challenge of a high number of child deaths despite the recorded decline over the years. As individuals and households experience child deaths personally and around their environments, it subconsciously influences their household choices towards further prevention. Thus, it is possible that households would seek to reduce or eliminate the use of solid fuel and other potentially harmful energy in order to reduce the level of morbidity and mortality and thus improve health outcomes.

The study will therefore proceed to examine the influence of under five mortality on the energy choice of households. The multinomial logit model of energy choice was thus estimated for the two categories of number of child death experience.

The number of child deaths reported by women ranged between 0 and 20 with 69.27% of zero deaths among children. 28.63% were deaths ranging between 1 and 3 child death experiences by a woman. Some women reported having between 4 and 8 child deaths and this made up 2.08% of the total number of child deaths. Child deaths ranging between 9 and 20 made up 0.01% of under five mortality.

Estimating the energy demand model for households, we show the differentials by the experience of child deaths by households. The two categories of child deaths used include households that experienced zero or no child death, and those that experienced at least 1 child death.

The energy cooking choice of households that experienced no incidence of under five mortality were mostly significantly influenced by education and wealth as shown in Table 5. For the case of households that have no child death experience, we expect that they would either want to take precautions to prevent death or they would be less careful since they have no experience of under five mortality. The results showed that rich households were significantly more likely to use all the energy cooking types thus confirming the energy stacking behavior model. Rich households are able to demand for all cooking fuel types in order to increase the alternatives available for use than poor households. Households in the middle wealth quintile were significantly more likely to use natural gas and kerosene rather than coal or firewood. They are not so rich to afford cleaner energy such as electricity, however they get to use more of natural gas and kerosene than poor households. This emphasizes the importance of wealth for the affordability of clean energy. Both primary and secondary education did not significantly increase the use of electricity, which is a very clean energy type. Thus a primary or secondary education is not sufficient to influence clean energy use with regards to electricity. Having a post secondary education increased the likelihood that a woman's household would choose to use any of the energy cooking types rather than firewood or coal. Thus, women in such households were more likely to use natural gas and kerosene than firewood or coal. This implies that, such households are more likely to stack energy in order to increase the substitutes available

for their use. Even in households with zero under five mortality experience, older women and older household heads were still more likely to use other fuel types except electricity. Employed women are more likely to use natural gas and kerosene than unemployed women. Thus although households with zero child deaths preferred to use other fuel types besides firewood and coal which is the dirtiest, it required a post secondary education and a rich household to ensure the use of one of the cleanest energy type which is electricity.

Examining the case of households with the experience of at least one child death, the results are presented in Table 6. We found that those in the middle wealth quintile were significantly more likely to use kerosene than firewood, coal or other solid fuel types. Thus, middle households would prefer to move away from solid fuels to

a relatively cleaner form of energy such as kerosene. As shown in Table 6, rich households are also more likely to use all the other cooking fuel types rather than firewood or coal. Thus, despite their use of clean fuel such as electricity, rich households still stack up other fuel types probably to serve as standby substitutes when the need arises (especially in Nigeria where electricity power supply is inconsistent and gas scarcity is possible). Thus, health considerations are not taken seriously since less cleaner fuels including kerosene are still being used.

The effect of education is the same for primary and post secondary education as women with such education are significantly more likely to use natural gas and kerosene. Thus, just having an education does not automatically mean that a woman would allow her health experience and that of her

**Table 5: Estimates of the cooking energy choice model for households with zero child deaths**

Variables	Coefficient (t-statistic)[Std. error] Electricity	Coefficient (t-statistic) [Std. error] LPG/ Natural gas/Biogas	Coefficient (t-statistic) [Std. error] Kerosene	Coefficient (t-statistic) [Std. error] No food cooked in house
Probability that household is poor	RC	RC	RC	RC
Probability that household is in the middle	1.765 (1.61)[1.096]	1.043 (2.24)**[0.466]	2.713 (8.17)*[0.332]	0.130 (0.71)[0.183]
Probability that household is rich	4.701 (4.74)*[0.991]	5.002 (12.34)*[0.405]	5.016 (15.55)*[0.323]	0.576 (3.38)*[0.171]
Woman's education				
No education	RC	RC	RC	RC
Primary education	0.469 (0.94)[0.497]	0.954 (3.92)*[0.243]	1.042 (6.59)*[0.158]	0.431 (1.83)[0.235]
Secondary education	0.496 (1.23)[0.402]	1.831 (8.82)*[0.208]	1.381 (9.89)*[0.140]	0.801 (4.07)*[0.197]
Post-secondary education	1.518 (3.53)*[0.430]	3.122 (14.55)*[0.215]	1.439 (9.13)*[0.158]	1.434 (5.88)*[0.244]
Woman is unemployed	RC	RC	RC	RC
Woman is employed	-0.191(-0.79)[0.241]	0.284 (3.31)*[0.086]	0.277 (3.58)*[0.078]	-0.167(-1.16)[0.144]
Woman's age	0.024 (1.41)[0.017]	0.056 (8.51)*[0.007]	0.044 (7.66)*[0.006]	-0.024(-2.45)**[0.010]
Household characteristics				
Male headed household	RC	RC	RC	RC
Female headed household	0.194 (0.66)[0.295]	-0.151(-1.38)[0.110]	0.160 (1.67)[0.096]	0.846 (5.11)*[0.166]
Age of household head	-0.022(-1.74)[0.013]	-0.013(-3.74)*[0.004]	-0.014(-3.88)*[0.004]	0.053 (11.84)*[0.004]
Household size	-0.184(-4.15)*[0.044]	-0.275(-13.01)*[0.021]	-0.239(-13.94)*[0.017]	-0.016(-0.74)[0.021]
Wald Chi <sup>2</sup>	2762.06	2762.06	2762.06	2762.06
Prob >Chi <sup>2</sup>	0.0000	0.0000	0.0000	0.0000

\* and \*\* imply significance at 1% and 5% levels respectively. RC: Reference category. Base outcome: Coal/Charcoal/Firewood/other solid fuel

**Table 6: Estimates of the cooking energy choice model for households with at least one child death**

Variables	Coefficient (t-statistic) [Std. error] Electricity	Coefficient (t-statistic) [Std. error] LPG/ Natural gas/Biogas	Coefficient (t-statistic) [Std. error] Kerosene	Coefficient (t-statistic) [Std. error] No food cooked in house
Probability that household is poor	RC	RC	RC	RC
Probability that household is in the middle	2.139 (1.74)[1.228]	1.101 (1.59)[0.692]	2.847 (4.62)*[0.616]	0.366 (0.99)[0.370]
Probability that household is rich	3.947 (3.39)*[1.165]	4.394 (7.86)*[0.559]	5.173 (8.67)*[0.597]	0.829 (2.14)**[0.387]
Woman's education				
No education	RC	RC	RC	RC
Primary education	0.825 (0.93)[0.884]	0.850 (2.15)**[0.395]	0.953 (3.32)*[0.287]	0.503 (1.29)[0.391]
Secondary education	0.926 (1.09)[0.852]	1.325 (3.79)[0.349]	1.198 (4.49)*[0.267]	0.979 (2.38)**[0.411]
Post-secondary education	1.613 (1.65)[0.976]	3.136 (8.52)*[0.368]	1.337 (3.94)*[0.339]	0.084 (0.08)[1.097]
Woman is unemployed	RC	RC	RC	RC
Woman is employed	-0.725(-1.48)[0.488]	-0.076(-0.33)[0.234]	-0.095(-0.52)[0.183]	0.043 (0.14)[0.312]
Woman's age	0.063 (2.29)**[0.027]	0.041 (2.59)*[0.016]	0.021 (1.71)[0.013]	-0.048(-2.11)**[0.023]
Household characteristics				
Male headed household	RC	RC	RC	RC
Female headed household	-0.283(-0.42)[0.680]	0.305 (1.18)[0.258]	0.302 (1.44)[0.210]	1.313 (3.22)*[0.407]
Age of household head	-0.050(-1.81)[0.028]	-0.017(-1.90)[0.009]	-0.010(-1.27)[0.008]	0.032 (3.16)*[0.010]
Household size	-0.242(-2.07)**[0.117]	-0.219(-5.26)*[0.042]	-0.308(-7.51)*[0.041]	0.057 (1.37)[0.042]
Wald Chi <sup>2</sup>	747.51	747.51	747.51	747.51
Prob >Chi <sup>2</sup>	0.0000	0.0000	0.0000	0.0000

\* and \*\* imply significance at 1% and 5% levels respectively. RC: Reference category. Base outcome: Coal/Charcoal/Firewood/other solid fuel

household to influence the type of energy used in her household. It is possible that despite their knowledge, such women do not see any direct or seriously dangerous link between the cooking fuel type and the health status of household members and so do not allow it influence their decision on cooking fuel type. Further enlightenment and communications through the media, public health programmes and research outputs are therefore necessary interventions. Woman's employment, residing in a female headed household and the age of the household head did not significantly determine the use of any of the cooking fuel types. An increase in the household size however significantly reduced the likelihood that a woman would use electricity, natural gas or kerosene rather than firewood or coal. Thus, larger households were more likely to use firewood or charcoal since the resources or expenditure per household member declines as household size increases.

## 5. CONCLUSION

In summary, education and household wealth significantly determined the use of cleaner energy sources such as electricity and gas. Higher levels of education especially at the post secondary level, provide the necessary enlightenment on the health hazards and thus make educated women better able to appreciate the health gains from avoiding dirty or unclean energy. This was consistently obtained at the national level and in both urban and rural locations. The importance of affordability is shown by the significance of household wealth especially for rich households, which consistently were significantly more likely to choose clean cooking fuels including electricity and gas rather than firewood, charcoal and other solid fuels. The reduction effect of increasing household size on resources is seen as households are less likely to use clean energy such as electricity and gas. This was consistent for both urban and rural households.

Despite the fact that kerosene is not a clean fuel, richer households and more educated women were more likely to use it rather than firewood, charcoal and other solid fuels than uneducated women as well as poor households. This shows evidence of fuel stacking such that households mostly practice multiple fuel use so that there is a combined use of clean and unclean fuels, where the unclean fuels usually serve as backups.

Since education and household wealth are significant determinants of household cooking energy decisions, policy efforts must therefore be directed towards improving the welfare of households and their wealth generating opportunities in order to empower them to use clean energy. Policy strategies should also focus on improving educational attainments and wealth of households towards achieving the current United Nations appeal for energy transition to clean energy usage for global environmental protection and climate change mitigation. This is in line with the sustainable development goal of affordable and sustainable modern energy for all and consequently a healthier population.

Health considerations and experiences of households did not necessarily influence such household decisions. This study captured health outcome using child mortality however, further

studies could employ other health measures and conditions in order to examine whether the influence of household health experiences differ by the health outcome measure used.

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